

Standard Operating Procedure  
for  
Routine Operation of the Sequential Filter Sampler (SFS)

Prepared by:  
Desert Research Institute  
2215 Raggio Parkway  
Reno, NV 89512

Note: Contrary to the instructions in this SOP, both sides of the SFS sampler were used in CRPAQS. One side was operated with Teflon filters for mass and metals analyses, and the other side was operated in parallel with Quartz filters and NaCl impregnated cellulose backup filters for OC/EC and ion analyses. This SOP does not include any of the figures, DRI should be contacted to obtain a hard-copy with the figures.



## 1.0 GENERAL DISCUSSION

This document is the Site Operator Manual for the Sequential Filter Sampler (SFS) as used in the 1993-94 focusing study for the Dallas-Fort Worth Winter Haze Project. The operators' duties are described in Section 4. As background information, Section 1 provides a description of the measurement theory, Section 2 describes the instrument itself, and Section 3 provides a brief overview of calibration standards. Sections 5 through 7 describe calibration, quality control, and quality auditing procedures.

### 1.1 Purpose of Procedure

This procedure describes the operation of the sequential filter sampler for the collection of suspended particulate matter on Teflon filter substrates. The sequential filter sampler allows air to be drawn through a size-selective inlet and through the filter media. Solenoid valves controlled by a timer switch among five pre-mounted filters at preset intervals. The sequential sampling makes it unnecessary to have a person present at the site each day for every sample changing interval.

### 1.2 Measurement Principle

The sequential filter sampler used in this project has a Bendix 240 cyclone to select only those particles less than 2.5  $\mu$ m in aerodynamic diameter, called PM<sub>2.5</sub>. Open faced filter packs located inside each plenum are connected to solenoid valves which open when a sample is to be exposed. A vacuum pump draws air through these filters when the valves are open. The flow rate is controlled by maintaining a constant pressure across a valve with a differential pressure regulator. In this study, samples are taken from 0700 to 1500 CST daily.

The PM<sub>2.5</sub> samples are taken on numbered filter packs in Nuclepore polycarbonate filter holders labeled LNFT. The filter packs are placed in sampling ports 1 through 5 (#6 is a blank port) and consist of a Gelman (Ann Arbor, MI) polyolefin ringed, 2.0 micron pore size, 47 mm diameter PTFE Teflon membrane filter (#RP2J047), and a Nuclepore

(Pleasanton, CA) 47 mm diameter fiber drain disk (#231100).

Each filter pack has air drawn through it at 20 lpm (liters per minute). A makeup flow rate of 93 lpm is drawn through a separate port to provide the 113 lpm flow rate required by the inlet to maintain a particle cut point of 2.5  $\mu$ m. All flow rates are measured at each site visit with a rotameter transfer standard. Elapsed time meters on each channel measure the sample duration. The timing sequence is set for continuous sampling, so following completion of sampling on port 5, the SFS automatically switches to port 1. Dynamic field blanks are located in port 6.

Figure 1-1 illustrates the flow diagram of the PM<sub>2.5</sub> sequential filter sampling system. Note that only one side of the sampler will be used ports 1-6). The flow through ports 7-12 has been disabled for this study.

### 1.3 Measurement Interferences

1.3.1 Passive Deposition. Passive deposition occurs when particle and gases deposit on filters prior to and after sampling. Field blanks are used to quantify this bias, which is usually less than 30  $\mu$ g of mass per filter. The concentration of other deposited species depends on the composition of particles and gases in the air being sampled.

1.3.2 Inlet Loading and Re-entrainment: Material collected in the size-selective inlet (particles larger than 2.5 microns) can become re-entrained in the sample flow. The PM inlet is cleaned after each 30 days of sampling to minimize overloading and re-entrainment.

1.3.3 Pump Exhaust Recirculation: Recirculation occurs when the pump exhaust, which contain carbon and copper particles from the motor armature and pump vanes, is entrained in the sampled air. Recirculation is minimized by running reconditioned pumps to "seat" the vanes prior to the sampling program, filtering exhausted air, and locating the pump exhaust inside an enclosure over 1 meter below the sampling inlet. Exhaust filters need to be

replaced when they show particle breakthrough as evidenced by black streaks on the external surface of the filter.

- 1.3.4 Filter Blanks: Teflon membrane filters are acceptance tested for trace level elements prior to use in a sampling program.
- 1.3.5 Filter Integrity and Contamination: Filter integrity can be compromised by handling, which causes pieces of the filter to be lost after the pre-exposure weighing. Filter contamination results from material other than sampled aerosol being deposited on the filter (e.g. fingerprints, dirt). The effects of filter material losses are minimized by performing gravimetric analysis on Teflon membrane filters which are minimally friable. Filter material losses and contamination are minimized by the placement and removal of filters to and from filter holders in controlled laboratory conditions. Gloved hands and forceps are used in this filter processing. Spare loaded filter holders are provided in the field and so there is no need for field loading and unloading. Each filter holder is separately sealed prior to and after sampling. Batches of filters are inspected and submitted to chemical analysis prior to use to ensure that they meet minimal standards when received from the manufacturer.
- 1.3.6 Particle Loss During Transport: Particles have been found to be shaken from filters during transport of coarse (greater than 2.5 microns) particles which are heavily loaded on the filter. For this study, only PM<sub>2.5</sub> will be collected, so particle loss should be minimal.
- 1.3.7 Transmission losses: The necessity of particles to pass through a size-selective inlet could result in particle loss. Calculations show that diffusion and impaction losses are negligible for PM<sub>2.5</sub> particles.

## 1.4 Ranges and Typical Values

The range of concentrations measured by this method is limited by the sensitivity of the analysis instrument and the standard deviation of the value obtained by the dynamic blank. For mass concentration, the range is approximately 5 to 300 **ug/m<sup>3</sup>** .

## 1.5 Typical Lower Quantifiable Limits, Precision, and Accuracy

For mass concentrations, the typical lower quantifiable limit is 2 **ug/m<sup>3</sup>** for the flow rates and sample duration's used in this program. The precision is calculated from replicate laboratory analysis and flow rate performance testing. This precision is better than the EPA **PM<sub>10</sub>** reference method requirements of + 3 **g/m<sup>3</sup>** (one standard deviation) for mass concentration less than 80 **g/m<sup>3</sup>** and +7% (one standard deviation) for mass concentrations which exceed 80 **g/m<sup>3</sup>**. Accuracy is generally within the measurement precision.

## 1.6 Responsibilities

The ENSR site operator technician is responsible for carrying out this standard operating procedure and for the completion and submission of all documents.

The ENSR field operation supervisor is responsible for scheduling the site operator visits, identifying and correcting deficiencies, and coordinating sample transfer with the laboratory.

The DRI laboratory supervisor is responsible for preparing samples, transmitting them to the field, receiving them from the field, reviewing documentation and sample integrity, and communicating deficiencies and remedial action to the field operation supervisor.

## 1.7 Definitions

The sequential filter sampler (SFS) is the entire sampling unit .

For **PM<sub>2.5</sub>** sampling, the cyclone is the size selective inlet

which provides the 2.5 micron cut-point for particles entering the sampler.

The gooseneck is the u-shaped tube which connects the cyclone to the SFS inlet. It is also used to check the total flow rate drawn through the SFS system.

The shroud is the enclosure which contains the gooseneck and the cyclone for the **PM<sub>2.5</sub>** inlet.

The bug screen covers the shroud opening.

The plenum is the chamber which encloses the filter holders.

The inlet duct connects the inlet to the plenum.

The makeup flow is the flow which is drawn through a plenum port with no filter so that the total flow through the inlet is 113 lpm.

## 1.8 Related Laboratory Procedures

DRI SOP #2-102.2      Gravimetric Analysis Procedure

DRI SOP #2-107.2      Procedure For Light Transmission Analysis

## APPARATUS, INSTRUMENTATION, SUPPLIES, AND FORMS

### 2.1 Instrumentation

2.1.1 Sequential Filter Sampler: The version of the SFS used in this project is shown schematically in Figure 2-1. Air enters the bug screen and inlet shroud. A **PM<sub>2.5</sub>** inlet is located at the center of the inlet duct to remove particles which are larger than 2.5 **m** in aerodynamic diameter. The sample stream flows into the plenum where filter holders are arranged in a circular pattern. The filter holders are connected to solenoid valves which are normally in a closed position unless activated by an electrical current directed by a stepper relay. The valves are opened so that the air passes

through one Teflon filter pack at a time. The same stepper relay activates one of six elapsed time meters which record the duration over which the valve is open. The timer advances the stepper relay to the next sampling port.

Each set of six sampling ports is connected to a separate vacuum manifold. The flow goes through the manifold, then through a differential pressure valve, a ball valve, and to a GAST 1022 or 1023 carbon vane pump. This pump has sufficient capacity to pull 20 lpm (liters per minute) through each filter pack and 93 lpm through the makeup air port. The differential pressure regulator maintains a constant pressure and, therefore, a constant flow across the ball valve. As the filter loads up, the pressure drop across this regulator decreases which sends a signal to the valve to open further and allow more air to pass. This then equalizes the pressure across the regulator.

2.1.2 Nuclepore Filter Holders: the filter holders are open faced and accommodate 47 mm diameter filters. The outlets have been bored to 3/8 inch diameter and fitted with quick disconnect barbs which allow connection to the quick disconnect fitting of the SFS. The anti-twist ring has also been machined to accommodate a stack of filters and viton O-rings have been used to minimize outgassing of organic carbon to the filter substrates.

Adhesive bar-coded ID codes are affixed to the filter holders when the filters are loaded in the laboratory. The first two characters (LN) designate the site ID, the third and fourth characters (FT) specify the filter pack type, and the last remaining digits are the numerical ID numbers.

2.1.3 Dwyer 10 to 100 SCFH (5 to 50 lpm) Rotameter with Nuclepore Holder Adapter: This rotameter is used to set and verify flow rate through the filter packs. It may also be used in place of the 40-400 SCFH (20 to 200 lpm) rotameter for checking the makeup flow when this makeup flow is less than 100



SCFH (50 lpm).

2.1.4 Dwyer 40 to 400 SCFH Rotamter with Nuclepore Holder Adapter: This rotameter is used to set and verify the makeup up flow rate when it exceeds 100 SCFH, and to set and verify the total flow rate into the inlet duct.

2.1.5 Bendix 240 Cyclone: This is the size-selective inlet which passes particles less than 2.5 microns when the actual flow rate through it is 113 lpm.

2.1.6 Leak-Testing Vacuum Gauge with Quick Disconnect Barb: This gauge is inserted in sampling port 5 to determine the vacuum which can be drawn. Less than 23 inches Hg vacuum indicates leaks in the system.

2.1.7 Two Plugs with Quick Disconnect Bar: Since two ports are drawing air simultaneously, one of them is plugged with one of these plugs when leak testing is being done.

2.1.8 Spare Solenoid Valves, Flow Regulators, Stepper Switches, Carbon Vanes, GAST 1022 Pump, Grasslin Timer and Cyclone: these spare parts are used to replace parts in the SFS which are found to be faulty in the field.

## 2.2 Supplies

2.2.1 Pump Exhaust Filters: GAST #A393 cylindrical exhaust filters are replaced on a monthly basis or when they show signs of carbon breakthrough.

## 2.3 Data Sheets

Figure 2-2 illustrates an example of a data sheet as it comes in the cassette bag prior to sampling. Figure 2-3 illustrates an example of a data sheet after it has been filled out by the field technician. SFS field data sheets are prepared in triplicate. The pink copy is retained in the laboratory after unexposed filter packs are loaded in the carrying case as part of the sample chain-of-custody. The yellow copy is kept in

the field office after sampling. The original(white) data sheet is returned to the laboratory with the exposed filters.

### 3.0 CALIBRATION STANDARDS

The transfer standards for SFS flow rate are the rotameters specified above which have been calibrated against a Roots Meter prior to the beginning of the sampling program. Figures 3-1 and 3-2 show an example of a rotameter calibration log and calibration curve. The units on Figure 3-2 are SCFH. Elapsed time meters are calibrated against a stopwatch.

### 4.0 SAMPLER OPERATION

#### 4.1 Flow Diagram

Figure 4-1 summarizes the routine operating procedure for SFS operation. Filter changing and flow rate performance tests are performed at each site visit and require approximately 15 to 30 minutes. Exhaust filter replacement, inlet cleaning, and leak testing are carried out monthly and require an additional 30 to 60 minutes.

#### 4.2 Start Up

These start up procedures are performed at the beginning of the study and when the sampler has been disabled for monthly maintenance or repair. With the exception of cleaning (section 4.2.2), these procedure are not performed on routine site visits.

##### 4.2.1 Change Pump Exhaust Inlet and Outlet Filters:

Unscrew the glass jar enclosing the filters.  
Grasp the filter (work gloves are needed to avoid fiber slivers in the hand), pull downward slightly and unscrew the bottom filter retainer plate.  
Insert a new filter and finger-tighten the retaining plate. Wipe any residue from the glass jars before replacing them. Inlet filters need not be changed for the entire program unless the makeup air flow cannot attain it's correct flow rate.

4.2.2 Clean the sampler base and inside of plenum: With a damp, soft paper towel, wipe the sampler base and inside of the plenum. Wipe away excess water with

a dry towel. Wipe the outside of the plenum, the shroud, the inlet duct, and the sampler base in a similar manner.

- 4.2.3 Clean and Grease the cyclone in the **PM2.5** Inlet: remove the top bug screen from the shroud by loosening the hose clamp. Use a short screwdriver to loosen the hose clamp on the tygon tube which attaches the cyclone to the goose-neck. Remove the red cap and wipe it with Kim Wipes or Handi Wipes.

Soak the cap in methanol or isopropanol and rinse in tap water. Rinse the cyclone in tap water, then soak in methanol for 30 minutes. Thoroughly rinse the cyclone in tap water and let it dry. Replace the red cap. Replace the cyclone on the goose-neck by tightening the hose clamp and replace the bug screen. An extra cyclone should be used to prevent sampler downtime during cleaning. The cyclone is cleaned monthly.

- 4.2.4 Plug in the Sampler: The SFS uses approximately 8 amps of current during normal operation, though it can draw 20 amp or more when the pump starts. A 20 amp circuit is needed for each SFS. Where possible, the SFS should be directly plugged into an outlet. If an extension cord is needed, it should be extra heavy duty (10 or 12 gauge) and not more than 25 ft. in length. If the pump relay chatters when the pump is switched on, the voltage drop along the extension cord is probably too high. A heavier gauge or a shorter cord usually eliminates this chatter.

- 4.2.5 Program the Timer: Detailed instructions for the Grasslin 56-72 timer are attached. Read them. Channel one (CH 1) controls the pump, the solenoid valves, and the elapsed time meters. Channel two (CH 2) advances the stepper switch. Four features must be noted on the timer readout: 1) time of day; 2) am or pm; 3) day of week; and 4) on/off (or I/O). The on/off indicator refers to the current status of a channel--"ON" indicates that power is flowing and "OFF" indicate that it not. "I" is used in a program to turn power on and "O" is used to turn it off. The sequence of program steps is not

controlled by the order in which they occur, but by the times at which they are to occur. The timer contains a rechargeable backup battery which should last for up to two days after a power outage .

- ù Set the Current Time: Press the "Set Time" button and keep it depressed during the entire time-setting procedure. Press the button under the current day of the week until a bar appears over the day marker. Press the "h+" or "h-" button until the current hour appears in the center of the LCD display. Make certain that the "am" or "pm" designation on the left edge of the display is correct. Keep pressing the button until it is. Press the "m+" or "m-" button until the current minute appears on the display. Release the "Set Time" button and the current time should be displayed. The colon will blink only after a complete set of day and time information has been entered. It will not blink if an error has been made. The most common error is neglecting the day of the week.
- ù Program the Start and Stop times for Channel One: Push the "READ" and "CANCEL" buttons several times in succession until a blank display appears. This clears all previous programming steps. Push "Set Time" and the timer is prepared for programming. To program the timer for daily operation seven days a week, push the button corresponding to the day of the week until the bar on the D display appears over every day. To program the morning start time, push "h+" until 7 am is displayed in the hours column. Push "m+" until 00 is displayed in the minute column. Press the Channel 1 "I/O" button until the Channel 1 LCD marker is on "I". Press the "WRITE" button to record this program step. To program the daily stop time, press the appropriate buttons to obtain a time of 3:00 pm on the same day and press the Channel 1 "I/O" button until the Channel 1 display marks "0" (for OFF). Press the "WRITE" button to record this program step.
- ù Program the Filter Switching Times for Channel 2: A signal at the end of each day advances the solenoid

sequence to the next filter in preparation for the next day's sampling. Press the orange button which corresponds to the desired sampling day so that a bar appears over each day. Press "h+" and "m+" buttons until 2:59 p.m. shows on the display. Press "I/O" (channel 2) until a bar appears below the "I" for channel 2. Press "WRITE" to record this third step in the program. Repeat this procedure for the same day of the week, but for 3:00 p.m. using "h+" and "m+"; then press "I/O" (channel 2) so the bar appears below the "O" for channel 2; then press "WRITE" to enter this fourth step of the program. These two steps give the stepper relay a one minute electrical pulse between 2:59 and 3:00 to advance from one set of filters to the next.

Program Verification and Modification: Press "read" to sequence through each step in the program in order. When a change is desired in a step, the appropriate buttons can be pressed to make that change and it will be recorded by pressing "WRITE". Pressing "READ" will start at step number one when it is pressed following a "WRITE". The program

should read as follows on each sampling day:

R SFS TIMER PROGRAM 3Y		CH1	CH2
1	07:00am MoTuWeThFrSaSu		1
2	03:00pm MoTuWeThFrSaSu		0
3	02:59pm MoTuWeThFrSaSu		1
4	03:00pm MoTuWeThFrSaSu	O	
BLANK			
Push READ n times to read step n			
Push WRITE to modify a step			
Push CANCEL to turn a step into a blank			
LEAVE CHANNEL 2 OFF!!!			

4.2.6 Test the Timing and Switching Sequence: Flip the power switch to "ON"--this supplies power to all

sampler components. Press the Channel 1 "OVERRIDE" to turn the pump on and push the panel (not the timer) "RESET" button to set the sampling to port 1. The pump should start and the sample switching lights should indicate port 1. Elapsed time meter 1 should be moving. Cycle the timer by pressing Channel 2 "OVERRIDE" twice for each sequence. Make certain that the Channel 2 indicator is on "OFF" after the sampling port has advanced: this terminates current to the stepper relay. The relay coil may burn out if Channel 2 is let "ON". Verify that the ports advance through 2, 3, 4, and 5, and to the bypass flow. Press the panel "RESET" button to return to port 1.

4.2.7 Test for Leaks: Place the vacuum gauge in port 1 and a plug in port 13 with the sampler running on port 1. Record the reading in the station log book. Cycle through ports 1-6 and repeat the test. Finally, plug the filter port and measure the vacuum in the makeup flow port 13. If any reading is less than 23 inches, then there are leaks in the lines, valves, or manifolds which must be identified and corrected.

4.2.8 Set the Flow Rate: Follow the calibration procedure described in Section 5 to set flow rates to 20 lpm for ports 1 through 5 and to 93 lpm for port 13.

4.2.9 Verify the sum of flow rates: Remove the inlet and attach a gooseneck to the inlet duct. Place electrical tape around the mating joint to minimize leaks. Attach the 0 to 400 SCFH rotameter to the goose-neck. Place the plenum on the sequential sampler base with the test filter holder used for calibration on port 1. Cycle the timer so that this is the sampling port (the light will be on). Measure the total flow rate into the plenum, then add up the individual flow rates measured from ports 1 and 13 (ideally, 113 lpm). Calculate the ratio of sum to the total flow rate. If this ratio is less the 0.9, then there are excessive leaks through the plenum which must be identified and eliminated. Record the results of the test in the station log. BE SURE NEVER TO OBSTRUCT THE INLET WHEN THE PUMP IS ON: THE PLENUM WILL COLLAPSE.

### 4.3 Routine Operation

Routine site visits will be conducted on Mondays and Thursdays from November 15, 1993, through March 14, 1994. The only exception will be Thanksgiving Day, November 25; this site visit will be postponed until Friday, November 26. The first sampling day will be Tuesday, November 16, so filters placed in the sampler on November 15 will not begin exposure until the following day.

4.3.1 Inspect filters: Data sheets similar to Figure 2-2 are contained in plastic bags with the filter. Upon receiving a set of filters from the laboratory, open each bag and examine the filter: do this in a clean environment prior to visiting the site. Be sure each filter in the plastic bag is clean (no obvious foreign material on the filter). Replace any filters which do not pass inspection with one from the replacement bag and change the data sheet as described below.

The five replacement filters that have been supplied have IDs LNFT901-905. If a replacement filter needs to be used, select the one with the lowest ID number. Put an "R" in the flag column on the field data sheet, write "replaced by LNFT90x" in the comments column, along with a simple explanation of the problem. **DO NOT OBLITERATE THE BARCODE LABEL THAT IS ON THE FIELD DATA SHEET.** Return the damaged filter with the exposed ones when the filters are shipped to the laboratory.

4.3.2 Inspect SFS Sampler: Open the sampler door and compare the time on the timer with real time. Record the timer time and watch time at the top of the data sheet for the samplers in the sampler. Push the Channel 1 "OVERRIDE" button and record the port which is being sampled. Compare it to the sampling port which should be sampling. Note any discrepancies in the comments column of the data sheet. Push the panel "RESET" button to return the SFS to port 1. Push the channel 1 "OVERRIDE" to turn the pump off.

4.3.3 Record lapsed time and flow rate: Connect the 0 to 100 SCFH rotameter to the first set of samples as indicated by the data sheet using the filter holder adapter. Turn on the pump (push Channel 1 OVERRIDE") and cycle the timer to the port (push Channel 2 "OVERRIDE" twice for each cycle-- make certain the Channel 2 indicator reads "OFF"). Measure the flow rate from the rotameter and record it on the data sheet. Cycle to the other filters, measure their flow rate in the same way, and record the rates on the data sheet. Record the elapsed time meter reading for each port in the appropriate column on the data sheet.

4.3.4 Remove exposed filters: cover each exposed filter holder with it's red top cap, then remove the exposed filter holders by pulling the ring of the quick-connect fitting down from the filter holder, and pulling the filter holder out of the setting. If the site visit is between 7am and 3pm, do not remove the filter that is currently running . It must remain in the sampler to complete it's sampling period . Cover each filter holder with its bottom cap, and place them in their plastic bag. Verify that the correspondence between sampling port and ID which is indicated on the data sheet is the same as that which was sampled. If it is not, then note on the data sheet the correct correspondence. After filters are removed, wipe the inside of the plenum with a soft paper towel.

4.3.5 Install unexposed filters: Open the plastic bag of new filters, remove their bottom cap, and place the in the sampling port for each ID as indicated on the data sheet. Remove the top cap after the filter holders are in place. If a field blank cassette is included, it should be placed in port 6. To plug a filter holder into a quick-connect fitting, insert the barb into the fitting. Next, grasp the ring around the fitting and pull it down from the filter holder. Push the barb into the fitting. Release the ring on the fitting and push the filter holder toward the barb until a snap is heard as the ring moves toward the filter holder.



4.3.6 Measure pre-exposure flow rate: Connect the Rotameter to each filter holder and cycle through all samples. Record the pre-exposure flow rates on the data sheet. If the flow rates are not within +10% of the specified flow rate, there may be leaks in the system. First, check the Nuclepore filter holder to see if the assembly ring is loose. Tighten the ring and re-measure the flow. If the deviation is still too large, loosen the ring a quarter turn and re-tighten. This may re-seat the anti-twist ring. If the deviation remains large, swap the filter holder with the field blank or replacement cassette holder and re-test. If the flow rate is still out of specification, repeat the leak test and calibration procedures of Section- 4.2.7 and 4.2.8. Measure the makeup flow and enter it on the data sheet. If the makeup flow deviates by more than 10% from 93 lpm, adjust the makeup valve to the proper flow rate and re-check the individual filter flow rates.

4.3.7 Record the Elapsed Time: Record the elapsed time meter reading on the data sheet for the unexposed filters.

4.3.8 Reset the Sampling System: Place the sampling plenum on the SFS and secure it with the clamps. Reset the timer to correct time if it differs from watch time by more than 5 minutes. Cycle through the programs.

4.3.9 Monthly: Replace the pump exhaust filters and perform a leak test and a makeup air performance test.

4.3.10 A 14 step checklist is shown below and is to be used at each site:

1. Verify that proper sampling port is on.
2. Push Channel 1 override to turn pump off.
3. Record elapsed time on data sheet.
4. Measure flow rates and record on data sheet.
5. Calculate elapsed time.
6. Place top caps on exposed samples.
7. Remove exposed samples, place bottom caps on them, and put into Ziplock bag with data sheet.
8. Remove bottom caps and place unexposed samples on sampler. Remove top cap. Look at data sheet to match each filter pack to the proper port.

9. Measure low rate and record on data sheet.
10. Record beginning time on data sheet.
11. Assure that proper port is on. If the visit is between 7am and 3pm, this should be the same port and filter as when you arrived.
12. Cycle through timer program and verify it against the example at the end of Section 4.2.
13. Assure that Channel 2 is on "OFF".
14. Secure the plenum and ensure that the pump is running (if between 7am and 3pm).

DOUBLE CHECK:

Power switch is "ON"  
Current port POSITION is correct.  
Channel 1 is "ON" (during sampling).  
Channel 2 is "OFF".  
Plenum is secured.

- 4.3.11 Sample storage and shipping: Following each site visit, the plastic bag containing exposed filter cassettes and data sheet should be taken back to the ENSR Dallas office and stored in a clean, dry place. Approximately once a month, around the 1st of each month, the bag with exposed samples should be boxed and shipped to the laboratory. The address is:

Ms. Barbara Hinsvark  
Desert Research Institute  
P. O. BOX 60220  
5625 Fox Avenue  
Reno, NV 89506

#### 4.4 Shutdown

At the end of the sampling program in March 1994, perform one set of leak and performance tests prior to dismantling the sampler. Record the condition of the sampler in the station logbook. Check all equipment and parts against the check-out sheet and assure that all are packed for shipment back to the Desert Research Institute in Reno, NV.

## 5.0 QUANTIFICATION

### 5.1 Calibration Procedures

This flow check and adjustment is to be performed when the sampler is assembled in November, 1993.

#### 5.1.1 Mark Rotameter Scales with Correct Readings: The actual flow rate through each rotameter is

$$Q_{act} = (0.472)(aQ_i + b)((760/P_i)(T_i/298))^{0.5}$$

where

$Q_{act}$  = actual flow rate at temperature  $T_i$  (degrees Kelvin) and pressure  $P_i$  (mm Hg) in liters per minute

$Q_i$  = Rotameter reading in standard cubic feet per hour

$a$  = linear regression slope or relationship between rotameter reading and true flow rate at standard conditions-

$b$  = linear regression intercept for relationship between rotameter reading and true flow rate at standard conditions

Actual flows can be indicated on a piece of tape applied to the rotameter scale for typical temperatures and pressures in the sampling area. Slope and intercept are given in Figure 3-1.

#### 5.1.2 Connect Rotameters: Place the calibration filter pack labeled T on port 1. Connect the 0 to 100 SCFH rotameter to ports 1 and 13 using the adapters.

#### 5.1.3 Adjust Flows: Adjust the ball valve for port 13 until the actual flow reads 93 lpm. Adjust the ball valve for port 1 until the flow reads 20 lpm. Readjust the port 13 valve if this flow has changed.

5.1.4 Document Flow Through All Ports: Move the test filter holder to ports 1 through 5 and record the flow through each of the ports in the logbook. They should be within 1 lpm of the flow through port 1.

## 6.0 QUALITY CONTROL

6.1 Leak Checks: A leak check is performed every 30 days as described in Section 4.2.7.

### 6.2 Calibration Checks

A before and after flow rate measurement is made at every sample change.

## 7.0 QUALITY AUDITING

Audits of flow rates performed by an independent auditor with independent standards on a quarterly basis.

### Anchor Site SFS/Minivol Filter Log Procedure:

Note: Filters need to be removed by the day before DRI pickup at FSF.

1. Remove filters from SFS to:
  - a. Complete cycle by pickup date,
  - b. Avoid need for weekend removals.
2. Make a photocopy of the DRI chain of custody form and store it by sampler type.
3. Send a fax of the photocopy to Matt at 661-323-0307.

### Parsons Minivol Filter Log Procedure:

Note: Filters need to be logged and brought to FSF the day before DRI pickup at FSF.

1. Make 2 copies of paperwork brought in from field:
  - a. T&B Systems – Parsons is responsible for mailing this to Don,
  - b. Parsons – STI is responsible for maintaining an archive of this copy at Parsons.
2. Check all of sampled filters against the Parsons photocopy and put any inconsistent chain-of-custody forms in the Parsons inbox.
3. Archive the chain-of-custody and field forms by site and size cut.
4. Review the backlog of unsampled filters. Call Barbara Hinsvark if DRI's shipping schedule will not provide the needed additional filters.

SOP: Filter Log

Version: 1.0

January 14, 2000

## Memorandum

**DATE:** December 2, 1999  
**TO:** All Field Technicians for the CRPAQS Study  
**FROM:** Barbara Hinsvark, Lab Coordinator, DRI  
**RE:** Filter Pack Identification, Field Data Sheets

Filter Packs are identified with an alpha-numeric code: **XXXYYYnnn**, where

“XXX” is the site identifier. The official site codes (3,4,or 5 letter) for each site will be implemented in January, 2000. Until that time there is a cross-referenced DRI code.

“YYY” is the filter pack identifier, indicating the filter types inside:

TTC: “g” sampler. PM<sub>10</sub> Teflon filters backed by and separated from a citric acid impregnated filter in Nuclepore holders. Color Code PURPLE.

TQN: “h” sampler. PM<sub>10</sub> Quartz/ filters backed by and separated from a sodium chloride impregnated filter in Nuclepore holders. Color Code YELLOW.

FTC: “B” sampler. PM<sub>2.5</sub> Teflon filters backed by and separated from a citric acid impregnated filter in Nuclepore holders. Color Code GREEN.

FQN: “C” sampler. PM<sub>2.5</sub> Quartz/ filters backed by and separated from a sodium chloride impregnated filter in Nuclepore holders. Color Code RED.

GIF: “D” sampler. PM<sub>2.5</sub> Teflon impregnated glass fiber filters in Nuclepore holders. No Color Code. This sampling will begin later in the study.

“nnn” is the numeric identifier. All samples for a given day have the same numeric identifier.

Keep the red caps on the filter packs until they are ready to load. Unload the filter pack assembly from the portable sampler. Remove the impaction jet assembly from the exposed filter pack and replace the ring and red cap that was removed when it was loaded. Push the impaction jets out of the top assembly and put them in the bag with the exposed filter pack(s) which has its protective red cap in place. Clean the parts to be reassembled with the provided kimwipe, don't forget the rain cap, and insert the new clean jets. Take care if an FTC or FQN holder is being loaded: the

impaction jet with the larger hole is next to the rain cap. The adapter that holds the PM<sub>10</sub> impaction jet in series with the PM<sub>2.5</sub> impaction jet has been color coded to match the filter holder color. Make sure that the red gasket is in place in the bottom ring of the assembly.

Remove the red cap and the top ring from the new filter pack, screw the impaction assembly onto the top stage. The filter packs are loaded into the sampler by pushing straight down on the knurled section of the female quick release unit (connected to the plenum) until the ball bearings are visible, then inserting the male half of the quick release, releasing the female part, and pushing firmly down on the filter pack until it ‘snaps’ into place. Try not to use any sideways motion when inserting the filter pack because the male quick release (metal) could snap off of the holder (plastic). The filters for regular 6-day EPA sampling are packed by days and then assembled into a larger bag for each shipping period.

Each small bag contains the field data sheet (FDS) for that day. The field data sheets are imprinted with site code, barcode labels for that sampling site, date of sampling, and duration of sampling. It is very important that ALL REMAINING COLUMNS are completed since every column contains information that will provide for complete data processing as well as checks on the validity of the data. ANY INFORMATION THAT IS NOT RECORDED CAN CAUSE INVALIDATION OF THE SAMPLING PERIOD.

Use the Comments column for noting any unusual happening or condition that may affect the validity of the sample: power failure, pump failure, filter dropped when unloaded, etc.

The field data sheet also indicates when a field blank is to be loaded. There will be an extra filter pack in the bag and the field data sheet will indicate “blank” in the Comments column. The indicated field blank filter pack should be placed in an area near to the sampler, so that it will provide an indication of the ambient air at the sampler. These blanks will be used to determine the background levels of the sampled species.

Replacement filter packs have been shipped separately. It is recommended that you take a set with you when a site visit is made. The replacement filters packs are coded CZRYYYnnn. These are to be used when there is a problem with the assigned filter pack: broken inlets, dropped and dirty filters, wet filters before sampling, etc. Be sure the replacement filter is of the same type: TTC, TQN, FTC, FQN. Put this note in the comments section of the FDS: “Filter replaced by CZRYYYnnn.” Give a reason for the replacement. Inform your field manager when a replacement pack is used, so that he can notify me and I can replace it in the next shipment. Return all filter packs, including ones that are replaced or unusable. Parts are precious.

Please call me at 775-674-7040 ([hinsvark@dri.edu](mailto:hinsvark@dri.edu)), or Steve Kohl 775-674-7056 ([stevek@dri.edu](mailto:stevek@dri.edu)) with any question you may have, no matter how trivial it may seem. I have found it is easier to take a minute and answer a question at the beginning of a study than to try and unravel the errors at the end of the study.

xc: J. Chow, DRI

J. Watson, DRI

S. Kohl, DRI

D. Lehrman, T&B Systems



## Sequential Filter Sampler (SFS) at CRPAQS Sites

The operating period to which the following instructions apply starts 12/1/00 and ends 1/31/01. One 24-hour sample will be collected each day unless an Intensive Operation Period (IOP) is designated. During an IOP, five samples will be collected each day.

The five IOP samples will be collected during the following hours: 0000-0500, 0500-1000, 1000-1300, 1300-1600, and 1600-2400.

Before the possible IOP time, following programs should be installed in the Grässlin timer in the suggested order with the non-IOP On/Off settings:

Program	Channel	Day	Time	On/Off	
				Non-IOP	IOP
1	2	MTWTFSS	5:00 AM	<b>Off</b>	<b>On</b>
2	2	MTWTFSS	10:00 AM	<b>Off</b>	<b>On</b>
3	2	MTWTFSS	1:00 PM	<b>Off</b>	<b>On</b>
4	2	MTWTFSS	4:00 PM	<b>Off</b>	<b>On</b>
5	1	MTWTFSS	12:02 AM	On	On
6	2	MTWTFSS	11:59 PM	Off	Off
7	2	MTWTFSS	12:00 AM	On	On
8	2	MTWTFSS	12:01 AM	Off	Off
9	2	MTWTFSS	4:59 AM	Off	Off
10	2	MTWTFSS	5:01 AM	Off	Off
11	2	MTWTFSS	9:59 AM	Off	Off
12	2	MTWTFSS	10:01 AM	Off	Off
13	2	MTWTFSS	12:59 PM	Off	Off
14	2	MTWTFSS	1:01 PM	Off	Off
15	2	MTWTFSS	3:59 PM	Off	Off
16	2	MTWTFSS	4:01 PM	Off	Off

Channel 1 refers to the pump. Channel 2 refers to the filter advance. Note that only the first four programs, in bold type, need to be changed for the IOP On/Off settings.

1. On the day prior to an IOP:
  - a. Filter and program changes are made the day before the IOP begins. It will be easier if these changes can be made after 1600.
  - b. The sampler will be operating on channels x and x+7. Following the normal filter changing procedures, remove all exposed samples except the currently running sample. Keep the unexposed samples on the sampler.
  - c. Load new filters in the open ports.

- d. If the time is after 1600, change the first four programs on the timer from Off to On. If the time is before 1600, those filters that would start after the time of the filter changes will have to be left Off. They will have to be set to On during the next filter change.
  - e. Return sampler ports to position x and start pump to finish last 24-hour sample.
2. On the first day of the IOP:
- a. Filters should be changed before 1000 or after 1600 (before 1000 is recommended). That is, changes should not be made during the 3-hour samples (10-13 and 13-16).
  - b. Following the normal filter changing procedures, remove all exposed samples except the currently running sample.
  - c. Load new filters in the open ports.
  - d. If necessary, change program(s) that were not changed the previous day to On.
  - e. Return sampler ports to currently operating position and start pump to finish sample.
3. On subsequent days of the IOP:
- a. Filters should be changed before 1000 or after 1600 (before 1000 is recommended). That is, changes should not be made during the 3-hour samples (10-13 and 13-16).
  - b. Following the normal filter changing procedures, remove all exposed samples except the currently running sample.
  - c. Load new filters in the open ports.
  - d. Return sampler ports to currently operating position and start pump to finish sample.
4. On last day of IOP:
- a. Announcement as to end of intensive will be made by 12 noon on the day before the end.
  - b. If filter changes were made between 0800 and 1000, the On programs for the 05-10, 10-13, 13-16 (if after 1300), and 16-24 (if after 1600) will have to be set to Off. No filter changes need to be made.

5. On day after IOP:
  - a. Exposed filters should be changed before any of the multisamples, if any, that have not been changed to OFF are scheduled to run.
  - b. Those multisamples that were still set to On should be set to Off. The only On programs remaining should be Channel 1 (pump) at 12:02 am and Channel 2 (filter step) at 12:00 am.

